CLAIMS

What is claimed is:

1. A method for removing a red eye from an image, comprising:

calculating a weighted red value for each pixel in the image based on (1) red, green, and blue color values and (2) a luminance of each pixel in the image;

selecting a plurality of pixels in the image having weighted red values greater than a threshold as red eye pixels; and

correcting the red eye pixels to remove the red eye from the image.

2. The method of claim 1, wherein said calculating comprises:

$$f_1 = \frac{c_1^{(1)} r + c_2^{(1)} g + c_3^{(1)} b}{Y},$$

wherein $f_1$ is the weighted red value, $r$ is the red color value, $g$ is the green color value, $b$ is the blue color value, $c_1^{(1)}$ is a first weight given to the red color value, $c_2^{(1)}$ is a second weigh given to the green color value, $c_3^{(1)}$ is a third weight given to the blue color value, and Y is the luminance.

3. The method of claim 2, wherein $c_1^{(1)}$ is 0.5, $c_2^{(1)}$ is 0.5, $c_3^{(1)}$ is -1, $Y = 0.299r + 0.587g + 0.114b$, and the threshold is 0.5.

4. The method of claim 2, prior to said correcting, further comprising:

calculating another weighted red value for each pixel in the image from the red, the green, and the blue color values of each pixel in the image, comprising:

$$f_2 = \frac{c_1^{(2)} r + c_2^{(2)} g + c_3^{(2)} b}{Y},$$

wherein $f_2$ is said another weighted red value, $c_1^{(2)}$ is another first weight given to the red color value, $c_2^{(2)}$ is another second weigh given to the green color value, and $c_3^{(2)}$ is another third weight given to the blue color value; and

selecting another plurality of pixels in the image having another weighted red values greater than another threshold as additional red eye pixels.

5. The method of claim 4, $c_1^{(2)}$ is 0.6667, $c_2^{(2)}$ is 0.3333, $c_3^{(2)}$ is -1.0, $Y = 0.299r + 0.587g + 0.114b$, and the threshold is 0.5.

6. The method of claim 1, prior to said correcting, further comprising:

grouping a plurality of red eye pixels that are contiguous into a red eye region;

determining if the red eye region comprises a substantially round pupil; and

rejecting the plurality of red eye pixels if the red eye region does not comprise a substantially round pupil.

7. The method of claim 6, wherein said determining if the red eye region is substantially round pupil comprises:

determining a geometric center of the red eye region;

for each radius in a range of radii, determining a difference between (1) weighted red values of the red eye pixels located at a radius and at a range of angles about the geometric center and (2) weighted red values of the red eye pixels located at a next radius in the range of radii and at the range of angles;

selecting one radius in the range of radii that provides a largest difference as a pupil radius for the red eye region;

determining a first ratio of (1) a first number of the red eye pixels located in a circle having the pupil radius to (2) an area of the circular;

determining a second ratio of (1) a second number of the red eye pixels in a ring having an inner radius of the pupil radius and an outer radius of a maximum radius in the range of radii to (2) an area of the ring; and

determining a difference between the first ratio and the second ratio, wherein the red eye region does not comprise a substantially round pupil if the difference is less than a threshold.

8. The method of claim 7, wherein the range of radii ranges from 0.5 to 1.5 times a distance from the geometric center to a farthest red eye pixel in the red eye region.

9. The method of claim 6, further comprising:

determining if the red eye region is too close to another red eye region formed by grouping another plurality of red eye pixels that are contiguous; and

rejecting the plurality of red eye pixels if the red eye region is too close to said another red eye region.

10. The method of claim 9, wherein said determining if the red eye region is too close to another red eye region comprises:

determining if the geometric center of the red eye region is within a range of distances of said another geometric center of said another red eye region, wherein the range of distances is proportional to a pupil radius of the red eye region.

11. The method of claim 10, further comprising determining the pupil radius as follows:

determining a geometric center of the red eye region;

for each radius in a range of radii, determining a difference between (1) weighted red values of the red eye pixels located at a radius and at a range of angles about the geometric center and (2) weighted red values of the red eye pixels located at a next radius in the range of radii and at the range of angles; and

selecting one radius in the range of radii that provides a largest difference as a pupil radius for the red eye region.

12. The method of claim 11, wherein the range comprises 10 to 14 times the pupil radius.

13. The method of claim 9, further comprising:

determining if the red eye region is proximate to a facial region; and

rejecting the plurality of red eye pixels if the red eye region is not proximate to a facial region.

14. The method of claim 13, wherein said determining if the red eye region is proximate to a facial region comprising:

generating a histogram for pixels in a ring having an inner and outer radii proportional to a pupil radius of the red eye region;

selecting a most common color value in the histogram;

comparing the most common color to a range of threshold skin colors;

rejecting the plurality of red eye pixels if the most common color in the red eye region is not within the range of the threshold skin colors.

15. The method of claim 14, wherein said comparing comprises comparing the most common color value in HSV color space to the range of threshold skin colors in HSV color space.

16. The method of claim 14, further comprising determining the pupil radius as follows:

determining a geometric center of the red eye region;

for each radius in a range of radii, determining a difference between (1) weighted red values of the red eye pixels located at a radius and at a range of angles about the geometric center and (2) weighted red values of the red eye pixels located at a next radius in the range of radii and at the range of angles;

selecting one radius in the range of radii that provides a largest difference as a pupil radius for the red eye region;

17. The method of claim 16, wherein the inner and outer radii comprises of 4 to 9 times the pupil radius.

18. The method of claim 13, further comprising:

determining if the red eye region is proximate to a sclera; and

rejecting the plurality of red eye pixels if the red eye region is not proximate to a sclera.

19. The method of claim 18, wherein said determining if the red eye region is proximate to a sclera comprises:

generating a luminance histogram for pixels in a ring having an inner and outer radii proportional to the pupil radius;

selecting a brightest color in the luminance histogram;

determine a ratio between a number of pixels in the ring having the most brightest color to a number of red eye pixels within a circle having the pupil radius; and rejecting the plurality of red eye pixels if the ratio of the red eye region is less than a threshold.

20. The method of claim 19, further comprising determining the pupil radius as follows:

determining a geometric center of the red eye region;

for each radius in a range of radii, determining a difference between (1) weighted red values of the red eye pixels located at a radius and at a range of angles about the geometric center and (2) weighted red values of the red eye pixels located at a next radius in the range of radii and at the range of angles;

selecting one radius in the range of radii that provides a largest difference as a pupil radius for the red eye region;

21. The method of claim 20, wherein the inner and outer radii comprises 2 to 5 times the pupil radius.

22. The method of claim 1, wherein the method is implemented in software executed by a computer or firmware embedded into digital cameras, printers, scanners, or mobile phones.

23. A method for removing a red eye from an image, comprising:

calculating a weighted red value for each pixel in the image from a luminance, a red chrominance, and a blue chrominance values of each pixel in the image, comprising:

$$f_1 = \frac{1.41514(Cr-128)+1.23014(Cb-128)}{Y},$$

wherein $f_1$ is the weighted red value, $Cr$ is the red chrominance value, $Cb$ is the blue chrominance value, and Y is the luminance value;

selecting a plurality of pixels in the image having weighted red values greater than a threshold as red eye pixels; and

correcting the red eye pixels in the image.

24. The method of claim 23, prior to said correcting, further comprising:

calculating another weighted red value for each pixel in the image from the red, the green, and the blue color values of each pixel in the image, comprising:

$$f_2 = \frac{0.69662(Cr-128)-1.88671(Cb-128)}{Y},$$

wherein $f_2$ is said another weighted red value; and

selecting another plurality of pixels in the image having another weighted red values greater than another threshold as additional red eye pixels.

25. The method of claim 23, wherein the method is implemented in software executed by a computer or firmware embedded into digital cameras, printers, scanners, or mobile phones.